



Land Information and Property Data Update and Validation for Computer-Aided Facilities Management

¹Ayodele ODUWOLE & ²Gabriel Kolawole BABALOLA

¹Department of Surveying and Geoinformatics, the Federal Polytechnic Ilaro, Nigeria

²Department of Estate Management and Valuation, the Federal Polytechnic Ilaro, Nigeria

Corresponding author: ayodele.oduwole@federalpolyilaro.edu.ng

Abstract

Facility management has various stages and subsystems required to properly manage any facility. One of the various ways is to map out the entire place to show geographical relationships between facilities, which aids in a quick overview of any area of interest (AOI). The main purpose of this study is to create property data useful in mapping and managing facilities at the Federal Polytechnic Ilaro. Land allocation and space are the major focus of this study with facilities such as buildings, water tanks, generating plants, electric power poles, waste sites, and boreholes to be geospatially measured to show relationships, proximity, and other required details about them. Geographic Information Science (GIS), remote sensing and conventional surveying methods were combined for the acquisition of reliable land information and property data for computer-aided facility management system. The major outcome of this study is a data library created for facilities in the institution and maps showing layouts, themes of properties and facilities. We therefore recommended that a regular update be made to the facility data library to keep it active and current. This will aid real-time decision-making process and maintaining the facilities within the Federal Polytechnic Ilaro.

Keywords: *Buildings, database, facilities, GIS, Polytechnic*

INTRODUCTION

GIS or computer-aided management system technology provides a useful information framework to aid the effective management of any intelligent decisions on artificial and natural environments.

Facility management has various stages and subsystems required to properly achieve the management of any facility. One of the various ways is to map out the entire place to show geographical relationships between facilities, which aids quick overview of any area of interest (AOI). The major reason for this study is that there are no maps showing the location of newly constructed buildings in the institution. The advantages of facility management and property management are enormous and its contributions to the neighbourhood cannot be overemphasized.

The absence of updated digital map to show new building structures within the Institution. This deficiency has resulted to improper record keeping of allottees, double allocation and spending lots of time searching for information on the study area. As a result, these prompt the execution of this study by looking into the present level and extent of development on the study area and thus provide the necessary update. The main objective of this study is to update the existing property data with land information for a robust computer-aided facility management system. Therefore, information about the land areas where facilities exist will be digitized.

Project management refers to applying knowledge, skills, tools, and techniques to guide the project work to deliver the intended outcomes (PMI, 2017). Facility management is a service industry that manages various types of properties and business operations (Hou, 2023). Facilities planning, design, and management services are important and strategic to achieve the desired value that serves stakeholders' interests (Hou & Wu, 2020). An information system is an open system that seeks a set of related goals, producing information using the input-output cycle (Acoff, 1971) (Vankova et al, 2022).

Geographic Information System (GIS) is capable of handling both positional and attributes data (Ndokwe, 2001).

GIS Application in facilities management operations enhances keeping records of allocations and maintenance of property. It also helps managers to solve problems by making sound decisions regarding its facilities and building assets faster and better.

For a robust property/facilities management, a large volume of information are necessary. In so doing, a GIS database management is then created to facilitate the robustness.

Study area

The Federal Polytechnic, Ilaro is one of the federal academic institutions in southwestern, Nigeria. The Federal Polytechnic Ilaro is along Ilaro/Oja-Odan road and about 3km from the main town. It is about 60km from Idiroko, Nigeria Border town with Benin Republic. It also located within 06° 53’ 04” North and longitude 02° 59’ 03” East.

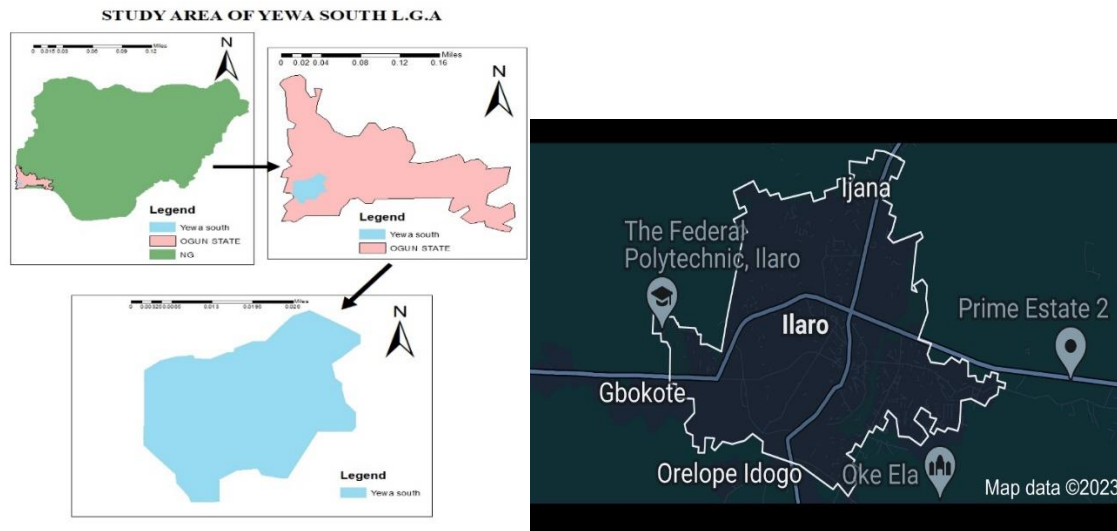


Fig. 1: The map of the study area

Methods and materials

The methods and procedures adopted for study were planning, data acquisition, data downloading, data processing and implementation. It describes the system selection process and instrument test.

The framework below was adopted for the study, and sectioned into four stages. These four stages are shown in fig 2 below and these included:

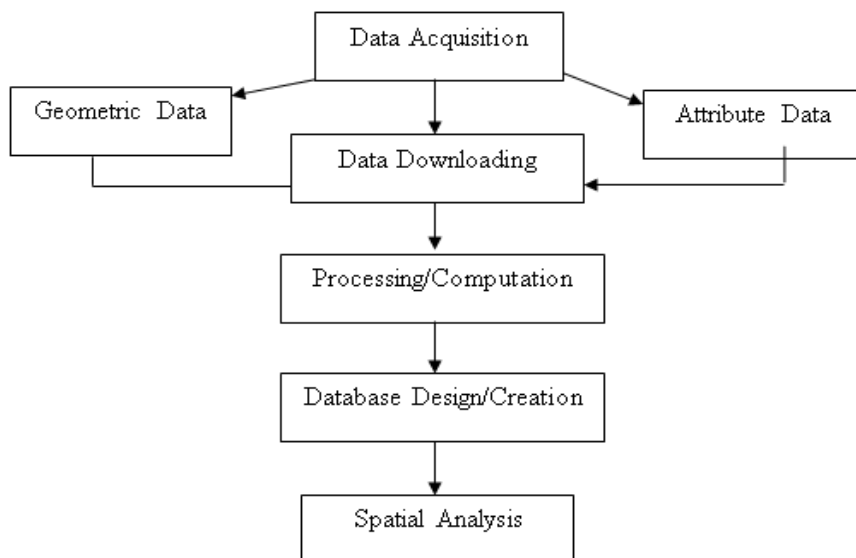


Fig. 2. Conceptual framework for the study (adapted from Alausa & Adaradahun, 2020)

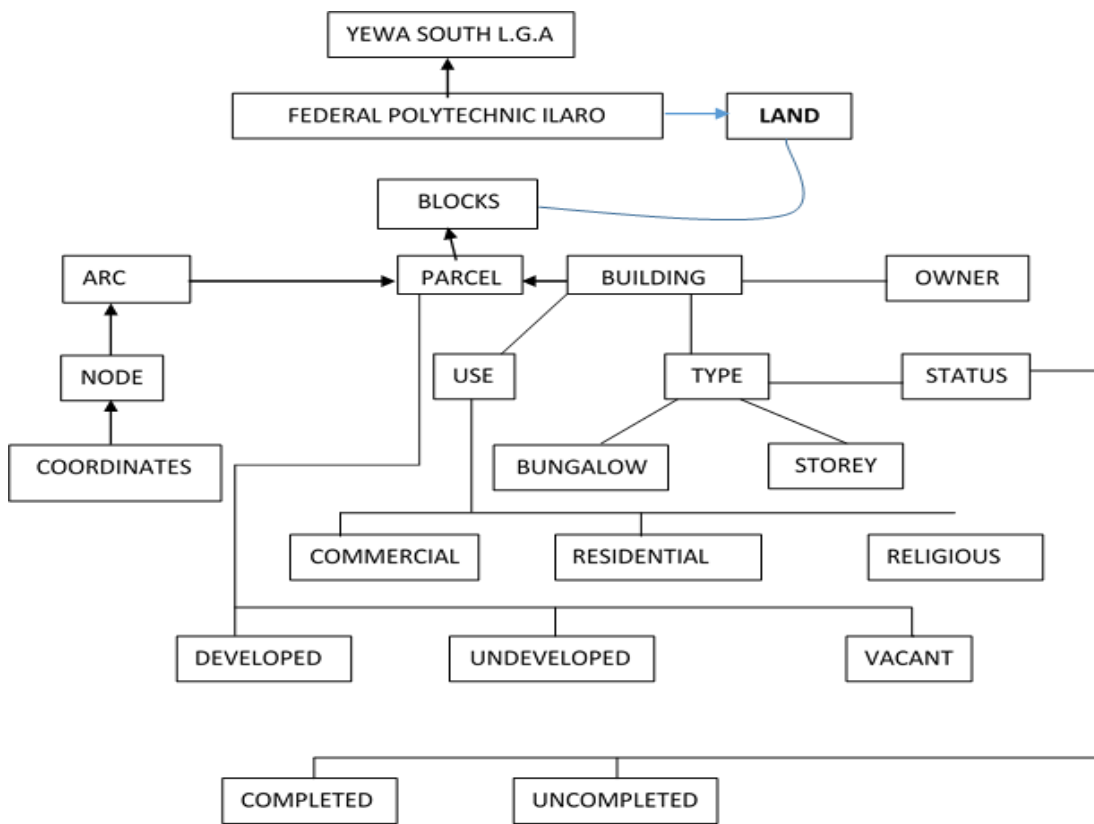


Fig 3. Enhanced Entity Relationship diagram of a land based information system (authors)

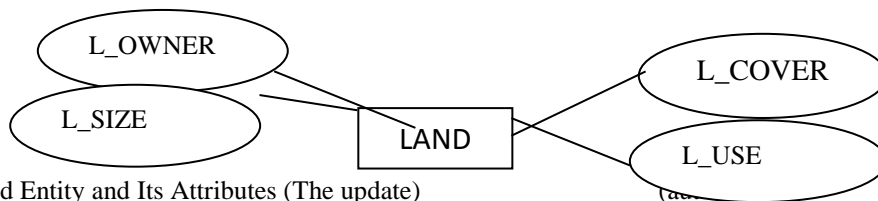


Fig 4. Land Entity and Its Attributes (The update)

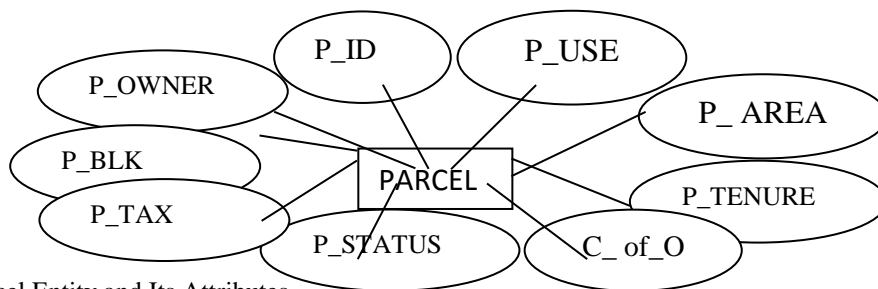


Fig 5. Parcel Entity and Its Attributes

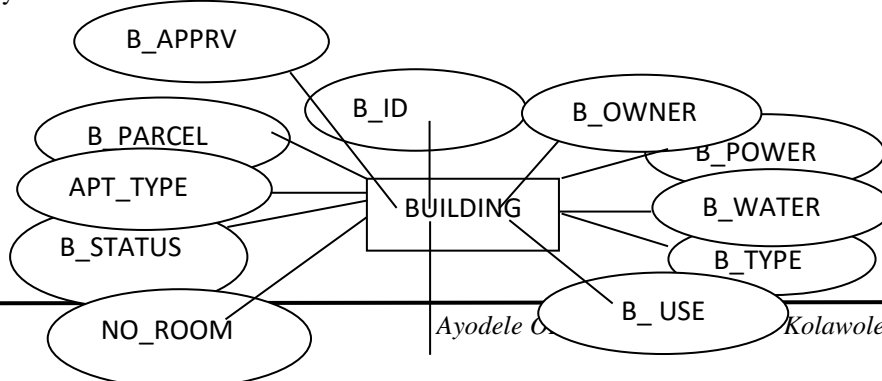




Fig 6. Building Entity and Its Attributes

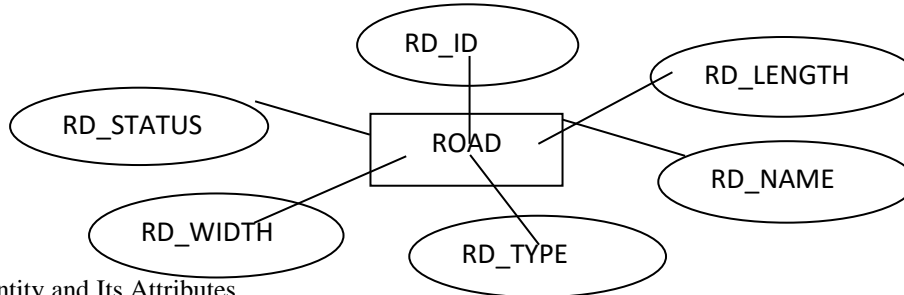


Fig 7. Road Entity and Its Attributes

Logical design

Here, the data are stored in simple relations known as Tables. **Land**, Parcel, Building, Road and Node tables were created. The relations for the logical data model for the Scheme are shown below.

Land Table

Land table (L_ID, L_Use, L_Area, C_of_O, L_Size, L_Cover). This identifies all the parcels on the plan that might be processed by the Geographic Information System and contains their attribute that uniquely identifies each parcel.

Description of Land Parameters

S/No	ATTRIBUTE NAME	ATTRIBUTE DESCRIPTION
1.	L_ID	Land Identifier
2.	L_Use	Land Use
3.	L_Area	Area of Land
4.	C_of_O	Certificate of Occupancy
5.	L_Size	Land Size
6.	L_Cover	Land feature distribution

Parcel Table

Parcel table (P_ID, P_Use, P_Area, C_of_O, P_Tenure, P_Owner, P_BLK). This identifies all the parcels on the plan that might be processed by the Geographic Information System and contains their attribute that uniquely identifies each parcel.

Table 3.1.2 Description of Parcel Parameters

S/No	ATTRIBUTE NAME	ATTRIBUTE DESCRIPTION
1.	P_ID	Parcel Identifier
2.	P_Use	Parcel Use
3.	C_of_O	Certificate of Occupancy
4.	P_Owner	Parcel owner
5.	P_Tax	Parcel Tax
6.	P_Tenure	Parcel Tenure

Building Table



Building table (B_ ID, B_ Owner, B_ Type, B_ Parcel, B_ Use, Rent_ Own, Rent_ Pd, B_ Status).

Description of Building Parameters

S/No	ATTRIBUTE NAME	ATTRIBUTE DESCRIPTION
1.	B_ ID	Building Identifier
2.	B_ Owner	Building Owner
3.	B_ Type	Building Type
4.	B_ Cond	Building Condition
5.	B_ Status	Building Status
6.	B_ Apprv	Building Approval
7.	B_ Use	Building Use
8.	B_ Tax	Building Tax

Road Table

Road table (R_ ID, R_ Name, R_ Length, R_ Width, R_ Condition, R_ Status). This table identifies each road to any parcel on the plan, such that it does not only uniquely identify the beginning and the end of arcs and corners of the parcel.

Description of Road Parameters

S/No	ATTRIBUTE NAME	ATTRIBUTE DESCRIPTION
1.	RD_ ID	Road Identifier
2.	RD_ Name	Name of the Road
3.	RD_ Length	Length of Road
4.	RD_ Width	Width of Road
5.	RD_ Status	Road Status

Data acquisition

This involves the processes in acquiring the data needed for the study. The Land Surveying Method was used to acquire data for the purpose of this study and the operation was divided into two phases which include the geometric data acquisition and the attribute data acquisition.

Before any data acquisition was carried out, it was necessary to carry out the reconnaissance (*Recce*) survey of the study area concerned which enabled us to know the easiest way in executing the task.

Geometric data acquisition

Geometric data acquisition was the first phase of data capturing and it was achieved with the aid of differential GPS and a Total Station (Sokkia 530R). It involves the collection of locational/ positional data of the spatial entities. It is the acquisition of the X, Y, Z coordinates of points of interest on the study site.

Control system validation

The fitness of use of the controls to be used for connection for the study was ascertained. It was carried out by setting the GPS base receiver on point GPS 04 and the rover receiver on the other controls. The instrument orientation and temporary adjustment were carried out.

Comparison of control

STATIONS	EASTING(m)	NORTHING(m)	HEIGHT
GPS 02	496935.000	762136.436	77.034
GPS 03	496948.319	762135.979	78.124
GPS 04	496947.834	762121.847	78.304



Observed control points

STATIONS	EASTING(m)	NORTHING(m)	HEIGHT
GPS 02	496935.012	762136.376	77.124
GPS 03	496948.296	762135.892	78.089
GPS 04	496947.789	762121.784	78.390

Discrepancy between existing controls and observed data

STATIONS	EASTING(m)	NORTHING(m)	HEIGHT
GPS 02	0.012	0.060	-0.090
GPS 03	0.023	0.087	0.035
GPS 04	0.045	0.068	-0.086

Database physical design

In conditioning the data, data type were considered and the relational data structure was translated to the database structure after specifying the correct data for each table in the implementing software (i.e. ArcGIS 10.6). The tables below show some of the data dictionary used.

Parcel Data Structure

Attribute	Description	Data Type	Character
P_ID	Parcel Identifier	Numeric	10
P_Owner	Parcel Owner	String	25
P_Status	Parcel Status	String	15
P_Use	Parcel Use	String	15
P_Area	Area of Parcel	String	7
C_of_O	Certificate of Occupancy	String	5
P_Tax	Parcel Tax	String	5
P_BLK	Parcel Block	String	10

Table 3.4.1 Building Data Structure

Attribute	Description	Data Type	Character
B_ID	Building Identifier	String	25
B_Owner	Building Owner	String	25
B_Type	Building Type	String	15
B_Area	Area of Land Building Occupied	Numeric	7
B_Cond	Building Condition	String	10
B_Status	Building Status	String	15
B_Apprv	Building Approval	String	10
B_Use	Building Use	String	20

Road Data Structure

Attribute	Description	Data Type	Character
RD_ID	Road Identifier	Numeric	5
RD_Name	Name of the Road	String	15
RD_Length	Length of Road	Numeric	5
RD_Width	Width of Road	Numeric	5



RD_Type	Road Type	String	20
RD_Status	Road Status	String	25

Table 3.4.3 Electric Pole Data Structure

Attribute	Description	Data Type	Character
EP_ID	Electric Pole Identifier	Numeric	5
EP_Eastings	Eastings Coordinate of EP	Numeric	10
EP_Northings	Northings Coordinate EP	Numeric	10

Database implementation

This involved the physical realization of the database and the application design. The database was created using ArcGIS 10.6 software after the completion of logical design by inputting the relevant spatial and attribute data into the system. In implementing this database, the spatial and attribute data were linked together so that queries can be generated to solve spatial problems. The procedures of creating the database and the relational table are highlighted in Appendices.

Attribute data table of the buildings

FID	Shape *	ID	Name	USE	STATUS
205	Polygon	0	GTRS	It is a building that functions as home / shelter	Completed
206	Polygon	0	GTRS	It is a building that functions as home / shelter	Completed
207	Polygon	0	BIG	It is a building that functions as home / shelter	Completed
208	Polygon	0	BIG	It is a building that functions as home / shelter	Completed
209	Polygon	0	D S A	This is a structure where students affairs are governed	Completed
210	Polygon	0	Taxation Department	It is a building of several offices of lecturers, Secretary and the Head of Department of Taxation department	Completed
211	Polygon	0	ASUP Hall	This is a building for multi-purpose functions such as partying, conference center and so on	Completed
212	Polygon	0	Toilet	It is a piece of hardware used for the collection of human urine and feces. It is sanitation facility at the user interface	Completed
213	Polygon	0	ANNEX HOSTEL	It is a building that functions as home / shelter	Completed
214	Polygon	0	Mass Communication Dept	It is a building of several offices of lecturers, Secretary and the Head of Department of Mass communication department	Completed
215	Polygon	0	S&D / QS DEPARTMENT	It is a building of several offices of lecturers, Secretary and the Head of Department of Surveying and Geoinformatic	Completed
216	Polygon	0			Completed
217	Polygon	0	TOILET	It is a piece of hardware used for the collection of human urine and feces. It is sanitation facility at the user interface	Completed
218	Polygon	0	TOILET	It is a piece of hardware used for the collection of human urine and feces. It is sanitation facility at the user interface	Completed
219	Polygon	0	AZ BLOCK	Building where lectures holds	Completed
220	Polygon	0	ERB	It is a building that functions as home	Completed
221	Polygon	0	EXAM OFFICE	This is a building containing several offices where examination activities takes place such as submitting of question	Completed
222	Polygon	0	STORE	A building where practical tools and other appliances are kept	Completed
223	Polygon	0	TOILET	It is a piece of hardware used for the collection of human urine and feces. It is sanitation facility at the user interface	Completed
224	Polygon	0	ERB	It is a building that functions as home / shelter	Completed
225	Polygon	0	GENERATOR HOUSE	Serves as a building the houses the generator	Completed
226	Polygon	0	ATM CENTER	A public use money dispensing facility	Completed
227	Polygon	0	USA ATM CENTER	A public use money dispensing facility	Completed
228	Polygon	0	250 Seaters B	Building where lectures holds and extra activities such as conference and examination hall	Completed
229	Polygon	0	250 Seaters A	Building where lectures holds and extra activities such as conference and examination hall	Completed
230	Polygon	0			Completed
231	Polygon	0	Bakery	This is a building where bread and other flour made goods are baked and sold out	Completed
232	Polygon	0	GENERATOR HOUSE	Serves as a building the houses the generator	Completed
233	Polygon	0	GENERATOR HOUSE	Serves as a building the houses the generator	Completed
234	Polygon	0	UKC		Completed
235	Polygon	0	MICRO-FINANCE BANK	A building where monetary activities takes place	Completed
236	Polygon	0	GEN HOUSE	Serves as a building the houses the generator	Completed
237	Polygon	0	ERB	It is a building that functions as home / shelter	Completed
238	Polygon	0	Hospitality Hall	This is a building set aside as a guest house and sometimes rest rooms for visitors	Completed
239	Polygon	0	Hospitality Hall	This is a building set aside as a guest house and sometimes rest rooms for visitors	Completed
240	Polygon	0	Conference Hall	This is a building set aside as a guest house and sometimes rest rooms for visitors	Completed
241	Polygon	0	Conference Hall	This is a building where conferencing are held and other sanitation program scheme	Completed
242	Polygon	0	SANIT		Completed
243	Polygon	0	KINGS PALACE	It is a building that functions as home / shelter	Completed
244	Polygon	0	AH BLOCK	Building where lectures holds	Completed
245	Polygon	0	AJ BLOCK	Building where lectures holds	Completed

(credits: Alausa and Adaradohun, 2020)

Query and presentation of analysis

Queries are specific questions asked such as “what is where?” and “where is what?” and answers provided algorithms. The responses are result of the relationship built between the entities and the respective attributes. However, the queries generated were in two forms viz; the single query criterion and multiple query criteria. The figure 4.1 shows the

Query 1

Query to show Parcels greater than 600sq.m in the study area.

Syntax modeled: "P_AREA_600" = 'YES'

Result:

The fig 4.2b shows the result of the query of the parcels of above 600sq.m. This information can help in regulating structures within the Institution.

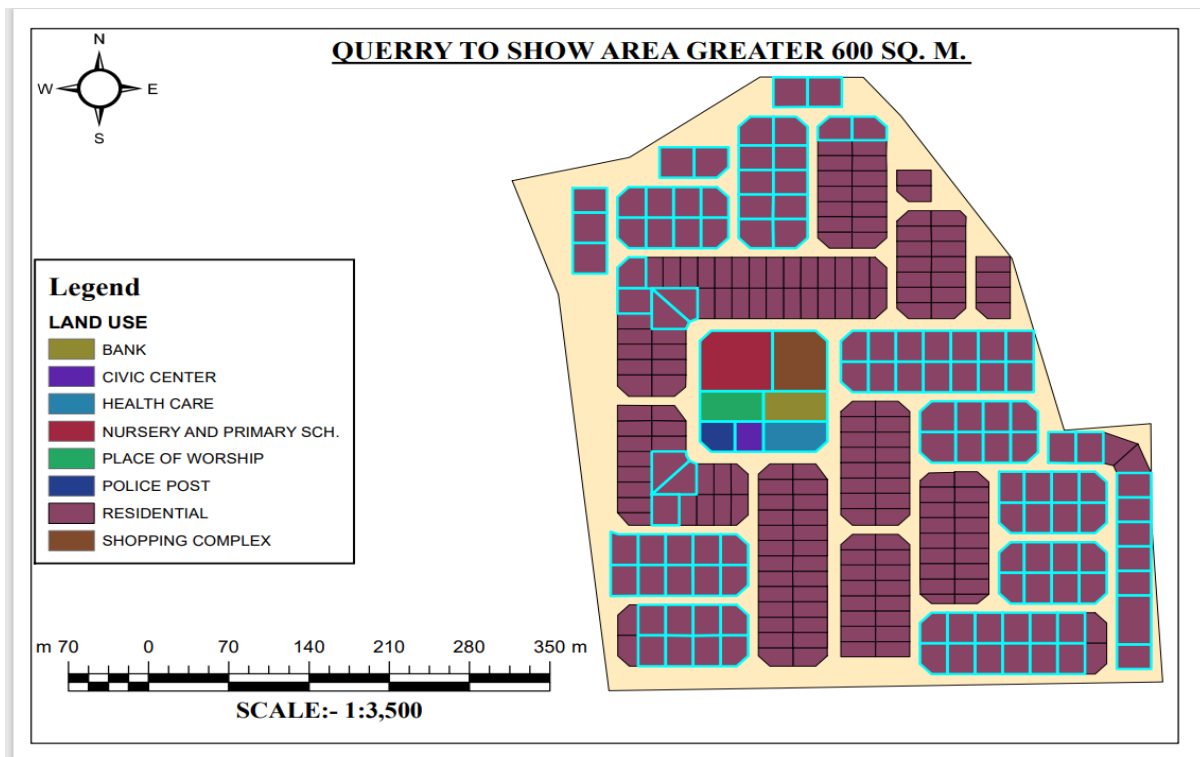


Fig. 8. Result of Query 1 displaying parcels of above 600sq.m in cyan

Table 6.1 Query to Show Area Greater Than 600 Sq.M

AREA	LANDUSE	EASTING	NORTHING	LENGTH	PLOT_NO	N0_BEACON	BLOCK_NO
873.4621	RESIDENTIAL	495995.399	762449.008	118.23	1.00	4.00	1.00
868.4316	RESIDENTIAL	496025.428	762449.092	117.89	2.00	5.00	1.00
798.5507	RESIDENTIAL	495966.158	762410.464	110.71	3.00	5.00	1.00
798.5535	RESIDENTIAL	495994.697	762410.464	110.71	4.00	5.00	1.00
720.0346	RESIDENTIAL	495995.427	762384.998	108.00	5.00	4.00	1.00
719.9653	RESIDENTIAL	495965.427	762384.998	107.99	6.00	4.00	1.00
721.2686	RESIDENTIAL	495965.436	762360.976	108.08	7.00	4.00	1.00

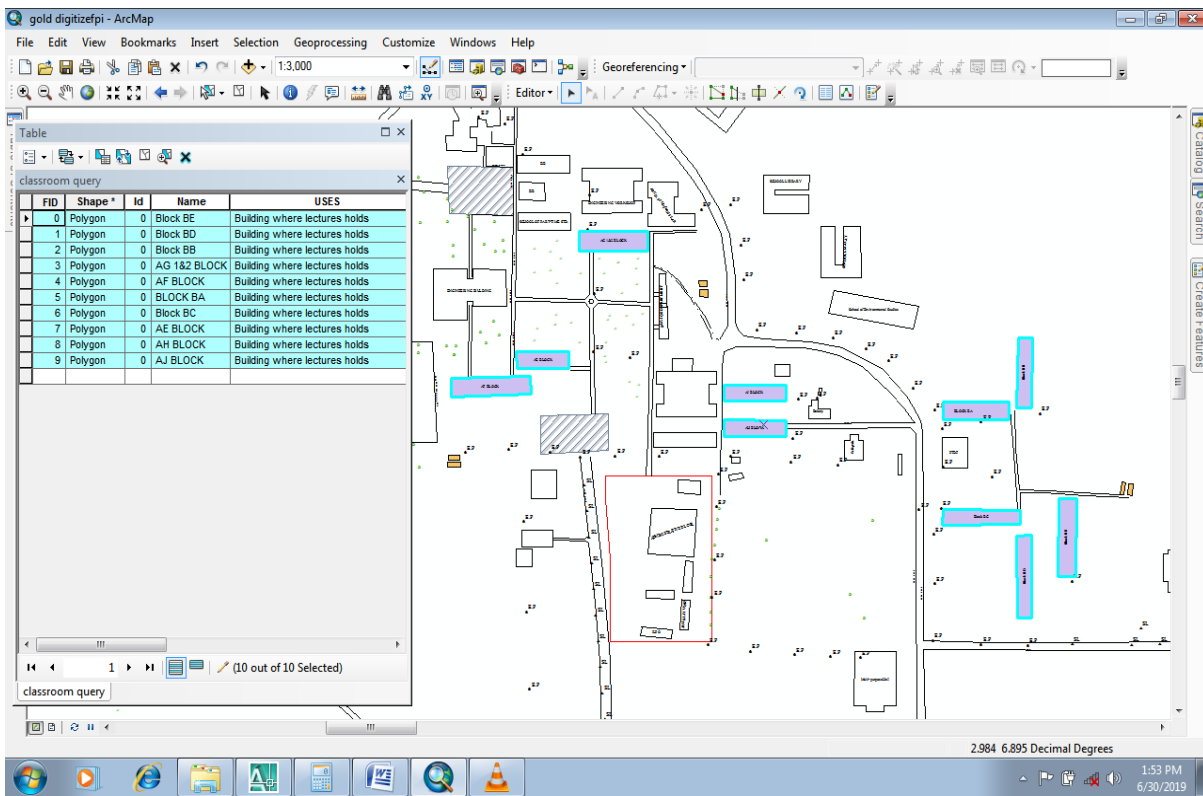
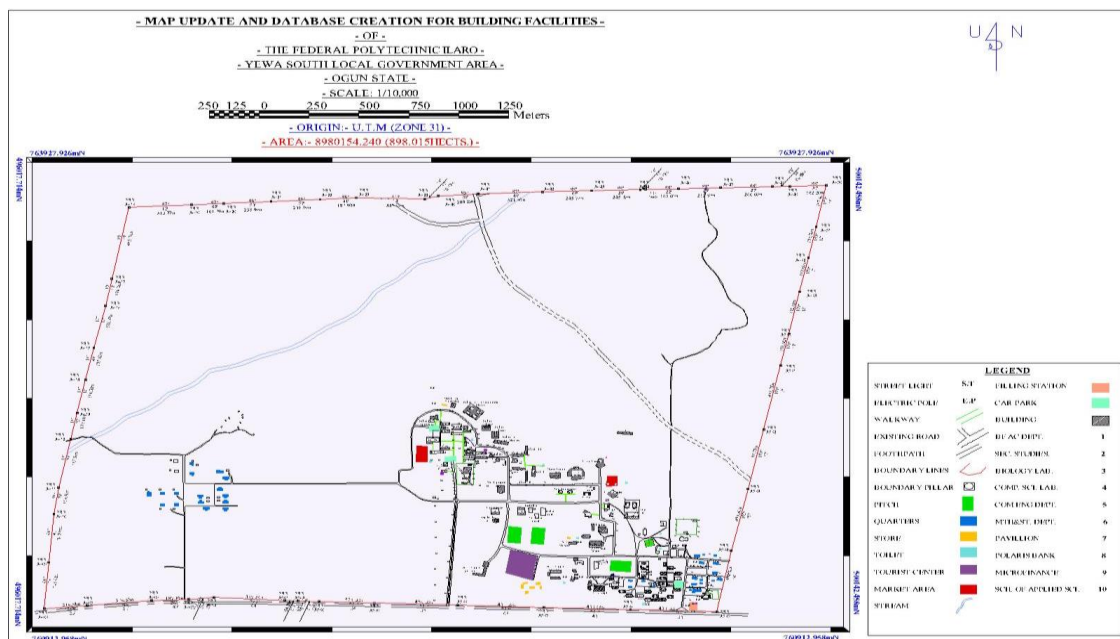


Fig 9: Showing Query of some lecture classrooms

Results analysis

The result generated from the various queries carried out earlier needs to be analyzed. In analyzing them various decision can be made from them, ranging from solution to other spatial related issue improving on effective management of the institution’s facilities, improve financial revenue and physical planning can be more effective.



10: Showing the updated map of the study area (credits: Alausa and Adaradahun 2020)



The outputs obtained from the query analysis confirms the robustness and ease of retrieving vital information about the facilities. The database management system created gave room for the efficiency of the computer-aided system.

Conclusion

This study addressed a lot of issues through geospatial analysis and data validation. An aspect of as-built survey was incorporated into the study as a quality control measure to establish discrepancies within the facilities constructed and their topology. Land as a resource has been catered for in the study with an enhanced entity relational diagram. Creating a database is very crucial and important task for the prosperous development of any rational economy, and having gone through the creation of spatial database for FPI Facility records, I hereby recommend as follows:

1. A robust system of the facilities within the Federal Polytechnic Ilaro be created, maintained and updated, which will make decision processes easy.
2. Works and service department should constitute a team of learned persons to understand the procedures and necessities in facility management.
3. Facility managers should always incorporate “land” in their computer-aided system

References

- Acoff, R. L. (1971); Towards a System of Systems Concepts. Management Science, vol.17, No.11, Pp 661-671.
- Alausa, O. A. & Adaradahun, O. S (2020). Map update and database creation for building facilities in the Federal Polytechnic Ilaro, Ogun State. Paper presented at the 2nd International Conference, The Federal Polytechnic, Ilaro, November, 2020
- Date, C. J. (2000): An Introduction to Database Systems. 7th Edition, Addison Wesley, P.7.
- Hou, C. (2023). Factors influencing smart facilities management–Stakeholder perspectives and the implication. Journal of Building Engineering. 75. 10.1016/j.jobbe.2023.106959.
- Hou, H. & Wu, H. (2020), "A case study of facilities management for heritage building revitalisation", Facilities, Vol. 38 No. 3/4, pp. 201-217. <https://doi.org/10.1108/F-02-2019-0020>
- Kroenke, D. & Hatch, R. (1994); Management information systems. 3rd Edition, McGraw-Hill, New York, P.1.
- Kufoniya, O. (1998): Database Design and Creation, Principle and Application of GIS, Pan-Africa Press, Lagos. Pp 46-48.
- Lo, C. P. & Yeung, K. W. (2003). Concept and Techniques of Geographic Information Systems. Prentice-Hall of India Private Limited, New Delhi, Pp 5, 392-404.
- Ndukwe, N. (2001): Digital Technology in Surveying and Mapping; Principle, Applications and Legislative Issues. Rhyce Kerex Publishers, Enugu. P.18-19.
- PMI, P. (2017). Project management body of knowledge (pmbok® guide). Project Management Institute, Inc.: Newtown Square, PA, USA.
- Vankova, L., Krejza, Z., Kocourkova, G. & Laciga, J. (2022). Geographic Information System Usage Options in Facility Management. Procedia Computer Science. 196. 708-716. 10.1016/j.procs.2021.12.067.
- Vanderwerf, R. T. (2001). The value of information technology in Real Estates and Facilities Management. http://www.facility.com/busfac/bf_03_05_cover2
- Vijayanand, K. & Venigandla, K. (2003). The Role of Computer Based Management Information Systems in Real Estates.
- Wertherbe, J. C. (1979); System Analysis for Computer based Information Systems. West Publishing Company, USA.



*Proceedings of the 4th International Conference, The Federal Polytechnic, Ilaro, Nigeria
in Collaboration with Takoradi Technical University, Takoradi, Ghana
3rd – 7th September, 2023. University Auditorium, Takoradi Technical University, Takoradi*

